Legal Medicine 17 (2015) 493–498

Contents lists available at ScienceDirect

Legal Medicine

journal homepage: www.elsevier.com/locate/legalmed

Postmortem magnetic resonance imaging: Reproducing typical autopsy heart measurements

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ARTICLE INFO

Article history:
Received 21 January 2015
Received in revised form 21 October 2015
Accepted 22 October 2015
Available online 23 October 2015

Keywords:
Virtopsy
Postmortem cardiac MR
Myocardial wall thickness
Heart valves circumference
Virtual autopsy
Forensic imaging

ABSTRACT

Purpose: The aim of this study was to evaluate the utility of cardiac postmortem magnetic resonance (PMMR) to perform routine measurements of the ventricular wall thicknesses and the heart valves and to assess if imaging measurements are consistent with traditional autopsy measurements.
Methods: In this retrospective study, 25 cases with cardiac PMMR and subsequent autopsy were included. The thicknesses of the myocardial walls as well as the circumferences of all heart valves were measured on cardiac PMMR and compared to autopsy measurements. Paired samples *T*-test and the Wilcoxon-Signed rank test, were used to compare autopsy and cardiac PMMR measurements. For exploring correlations, the Pearson's Correlation coefficient and the Spearman's Rho test were used.
Results: Cardiac PMMR measurements of the aortic and pulmonary valve circumferences showed no significant differences from autopsy measurements. The mitral and tricuspid valves circumferences differed significantly from autopsy measurements. Left myocardial and right myocardial wall thickness also differed significantly from autopsy measurements.
Results: Left and right myocardial wall thickness, and tricuspid valve circumference measurements on cardiac PMMR and autopsy, correlated strongly and significantly.
Conclusion: Several PMMR measurements of cardiac parameters differ significantly from corresponding autopsy measurements. However, there is a strong correlation between cardiac PMMR measurements and autopsy measurements in the majority of these parameters.
Conclusion: It is important to note that myocardial walls are thicker when measured in situ on cardiac PMMR than when measured at autopsy. Investigators using post-mortem MR should be aware of these differences in order to avoid false diagnoses of cardiac pathology based on cardiac PMMR.

1. Introduction

A large percentage of the cases investigated by forensic pathologists are related to natural causes of death, of which cardiac etiologies are the most common [1].

Ventricular myocardial wall thickness and the circumference of the heart valves can indicate the presence of cardio-vascular disease (CVD) and numerous studies reference normal ranges in literature [2–6]. According to Saukko and Knight, left ventricular thickening is an indicator for hypertensive heart disease, even if the heart weight is normal [7]. Heart valve lesions can lead to chronic cardiac dysfunction and death [8]. According to international recommendations and protocols, detailed descriptions, including weight, of each dissected organ, must be documented during autopsy [9].

Over the last decade, postmortem computed tomography and magnetic resonance imaging were introduced into the practice of forensic medicine [10–12]. Cardiac postmortem magnetic resonance (PMMR) is increasingly implemented in forensic routine in order to detect ischemia or coronary occlusion, as part of a virtual autopsy, frequently referred to as "virtopsy" [13–15]. The purpose of a virtual autopsy is dependent on the institution and may include: using virtopsy as adjunct to autopsy to improve quality, triaging natural causes of death from cases that need forensic autopsy, or replacing autopsy in selected cases. Thus, the potential of cardiac PMMR to support the conduct of autopsy and strengthen

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http://dx.doi.org/10.1016/j.legalmed.2015.10.008
1344-6223/

the validity of autopsy findings in cases of sudden cardiac death is an active topic of research [13,14].

However, the scientific literature lacks information regarding normal ranges for cardiac PMMR measurements.

The aim of this study was to evaluate the utility of cardiac PMMR to perform routine measurements of the ventricular wall thicknesses and the heart valves and to assess if imaging measurements are consistent with traditional autopsy measurements. We hypothesize that routine heart measurements on cardiac PMMR are comparable to the autopsy measurements.

2. Materials and methods

The responsible local justice department approved this study.

2.1. Subjects

We retrospectively reviewed all forensic cases from January 6, 2010 to June 8, 2010, in which cardiac PMMR and a complete forensic autopsy were performed. Cardiac PMMR examination was performed in every case of suspected cardiac death, following a whole body postmortem computed tomography (PMCT) examination. The cardiac measurements were not evaluated on the routinely performed unenhanced PMCT due to limited soft tissue differentiation. Cases exhibiting moderate/advanced decomposition changes were excluded from cardiac PMMR. For this study, all cases with hemopericardium and extensive myocardial hemorrhage were also excluded. The final study population consisted of 25 human cadavers (male/female ratio 15/10, mean age 48.6 years, standard deviation 17.7 years, age range 18–87 years).

2.2. Imaging protocol

Imaging was performed on a 1.5 Tesla MR scanner (Sonata, Magnetom, Siemens, Erlangen, Germany). All images used for this study were acquired with turbo spin echo T2-weighted (T2W) sequences. Short axis images were acquired with a repetition time (TR) of 3860–4620 ms, echo time (TE) of 100 ms, and a slice thickness of 2.0 mm. Four chamber views were acquired with a TR of 6170 ms, TE of 100 ms, and a slice thickness of 2.0 mm. Measurements were performed on a Picture Archiving and Communication System (PACS, IDS7, Sectra, PACS, Linköping, Sweden). Image

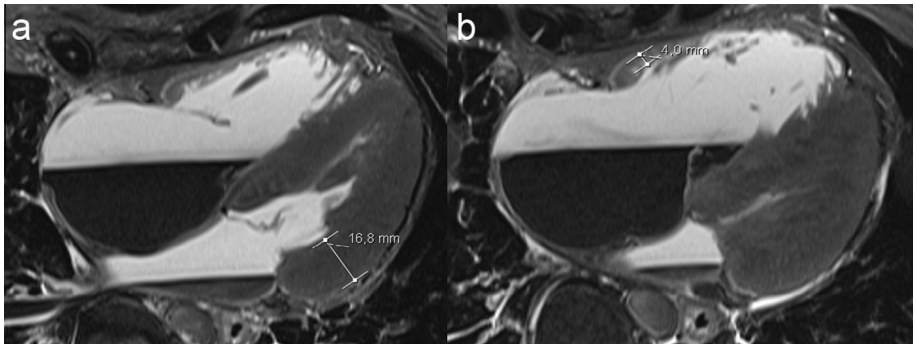

Fig. 1. Four chamber view of the heart, T2 weighted turbo spin echo sequence. Measurements of the myocardial thickness of the (a) left and (b) right ventricle. Note the typical postmortem sedimentation effect of the blood in the ventricles and atria.

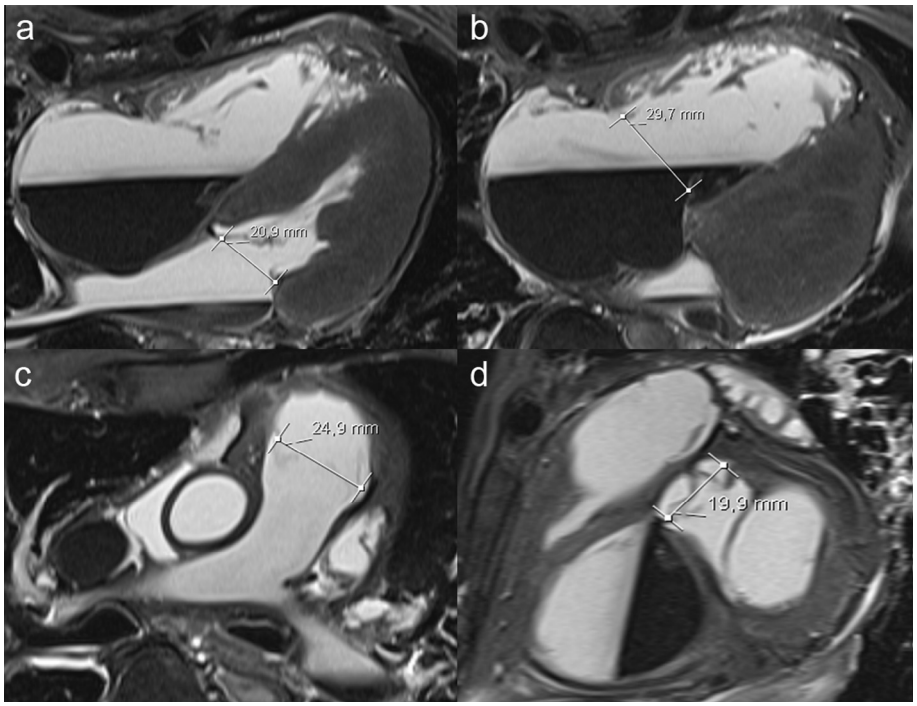

Fig. 2. T2 weighted cardiac PMMR, measurement of the diameter of the (a) mitral, (b) tricuspid, and (c) pulmonary valve in the four chamber view and of the aortic valve in the short axis view of the heart (d).